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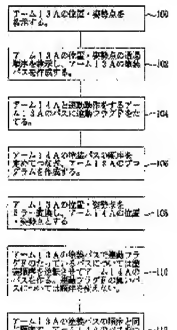
(54) TEACHING METHOD FOR COATING ROBOT

(57)Abstract:

PURPOSE: To provide a coating robot teaching method capable of shortening a span of teaching time sharply.

CONSTITUTION: An operating point and a passing order are taught to one side of two coating robots set up in an opposed manner in advance, and on the basis of these teaching data, a coating path is taught (steps 100 to 102). Next, an operating point of the coating robot on one side is taught to the coating robot on the other after mirror conversion, while the passing order is converted in reverse as to a pass operating in linkage with the coating robot on one side and taught as well, and a coating path is taught on the basis of those of operating point and passing order (steps 104 to 112).



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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the teaching method of the painting robot for starting a painting robot's teaching method, especially painting the body of a car.

[0002]

[Description of the Prior Art]When painting the body (body) of a car by two sets of paint machines, as shown in drawing 12, on coating quality reservation, two sets of paint machines must interlock and the general flat surface of the hood 2 of the upper surface of the body 1, the roof 3, and luggage 4 grade must operate.

[0003]Conventionally, in order to realize this, as shown in drawing 13, regularity carries out distance alienation and two sets of the atomized type spray painting machines 5A and 5B are connected, The method of equipping one NC (Numerical Control) type machine 7 grade with this connected unit, and operating these spray painting machines 5A and 5B with the control signal from the controller 6 based on teaching data was taken.

[0004]In painting with one painting robot, the flat surface, for example, the roof side, of a body of a car, The tip of the coating gun 9 grasped at the painting robot's 8 tip allocated in one side of a body as shown in drawing 14, From the paint starting point P1 on a roof side, it is made to be located in the point of having estranged only the constant distance d, and you teach the painting robot 8 this position, and make it located in the point that subsequently only the constant distance d estranged the tip of the coating gun 9 from the point P2 on a roof side in a similar manner, and this position is taught to the painting robot 8. Coating-locus P1->P2->P3-> which teaches the painting robot 8 each position of the point P1 - the point P10 which are hereafter shown in drawing 14 by repeating the same operation, and is shown to the painting robot 8 as the solid line a at the figure based on these teaching data -- The method of teaching ->P8 ->P9 ->P10 was taken conventionally.

[0005]

[Problem(s) to be Solved by the Invention]However, when painting the body of a car by two sets of paint

machines, in the conventional method of connecting two sets of the spray painting machines 5A and 5B as mentioned above, and making it operate. The coating area of these spray painting machines 5A and 5B turns into an upper area and a lower area among the figure to center line CL of the body 1, respectively, as shown in drawing 12, but. Since the solid lines A and B came to have shown the coating locus of these spray painting machines 5A and 5B to drawing 12, respectively, there was a problem that the coating locus which paints efficiently the portion which belongs, for example to the upper surface of the front pillar 11 or a body 1 called rear pillar 12 grade could not be made.

[0006]Namely, in order to paint the front pillar 11 and the rear pillar 12 efficiently, it is required to move each of the spray painting machines 5A and 5B along the elongation direction of these pillars, but. Since these spray painting machines 5A and 5B were connected, when painting the front pillar 11 on either side or the rear pillar 12, one spray painting machine had a problem that big lost motion (motion which carries out only movement without painting) will arise.

[0007]In order to solve such a problem, counter the both sides of the body 1 and the two painting robots 13 and 14 which can operate independently respectively as shown in drawing 15 are stationed, Along with the coating locus which these painting robots 13 and 14 show to drawing 15 as the solid lines A and B, respectively, it is necessary ganged operation or to carry out independent operation.

[0008]That is, it faces specifically painting the hood 2, the front pillar 11, the roof 3, the rear pillar 12, and the luggage 4 sequentially from the front of the body 1 with the two painting robots 13 and 14, and first, as shown in drawing 15, the hood 2 interlocks the two painting robots 13 and 14, and is painted. Interlocking the two painting robots 13 and 14 and painting them in this way, It is because the recoating portion of painting-robot entirety will not get used smoothly, but will pile up and a parting line will arise into a portion, if the paint by the painting robot of another side is not repeated before a solvent disperses and gets dry after painting with one painting robot. Next, although the front pillars 11 and 11 symmetrically provided by the painting robots 13 and 14 to center line CL are painted, on the occasion of this paint, independent operation of the painting robots 13 and 14 is carried out along the elongation direction of the front pillar 11 on either side, respectively, and they are painted. Then, although the roof 3, the rear pillar 12, and the luggage 4 are painted in this order with the painting robots 13 and 14, Like the case of the above-mentioned hood 2, the roof 3 and the luggage 4 carry out ganged operation of the painting robots 13 and 14, and paint them, and like the above-mentioned front pillar 11, the rear pillar 12 carries out independent operation of the painting robots 13 and 14, and paints them.

[0009]Although the problem of previous statement in the case of painting the body of a car with two painting robots by realizing the above-mentioned operation is solvable, it is necessary to form an operation plan detailed about two painting robots' each for realizing the above-mentioned operation, and to perform precise instruction. However, these operation plans and precision instruction had dramatically difficulty or the problem of having carried out and also taking time with **.

[0010]When painting the flat surface of the body of a car with one painting robot, Only the constant distance d makes a coating gun estrange from a painted surface about all the points like previous

statement, In the conventional method of teaching a painting robot the position for each point, and teaching a painting robot a coating locus based on these teaching data. Since the painting robot needed to be operated for each point and it needed to teach in spite of the repetition of operation simple as operation of a final painting robot, teaching work became complicated, and the great instruction man day was needed and, as a result, there was a problem of also taking instruction time very long.

[0011]This invention is made in view of the above point, and is a thing.

The purpose is to provide the teaching method of the painting robot which can shorten instruction time by facing teaching two painting robots which paint, teaching the painting robot which is one side beforehand, and teaching the painting robot of another side based on this teaching data.

[0012]Face other purposes of this invention teaching one painting robot which paints a painted surface, and carry out three-point attitude instruction of the operating point at least beforehand, and. It is in providing the teaching method of the painting robot which can shorten instruction time by specifying predetermined data and teaching a painting robot based on these operating points and tbe data.

[0013]

[Means for Solving the Problem]The invention according to claim 1 counters and stations two painting robots for painting a painted surface, Face teaching these painting robots' each, and teach one painting robot passing order of this one painting robot's operating point, and this operating point beforehand, and. Based on these operating points and passing order, teach this one painting robot's coating locus, carry out mirror conversion of said one painting robot's operating point to a painting robot of another side, and teach him the operating point of a painting robot of this another side, and. Inversion conversion of said one painting robot's passing order is carried out about a paint path which carries out ganged operation to said one painting robot, passing order of a painting robot of this another side is taught, and a coating locus of a painting robot of this another side is taught based on these operating points and passing order.

[0014]Face the invention according to claim 2 teaching a painting robot which paints a painted surface and which grasped a coating gun, to said painting robot, carry out three-point attitude instruction of the operating point which carried out prescribed distance alienation from said painted surface beforehand at least, and. From these operating points, compute a field corresponding to a painted surface, rank second, and specify the operating point of one point as the paint starting point among said operating points of three points, and. Other operating points which specify a feed direction, the amount of paint path pitches, and paint passing time of said coating gun at least, and differ from said operating point of three points in a field corresponding to said painted surface in said painting robot based on said specified data, Passing order of said operating point of three points, and the operating point besides the above is set up automatically and taught, and this painting robot's coating locus is taught based on these operating points and passing order.

[0015]

[Function]In the invention according to claim 1, the passing order of the operating point and this operating

point is taught to the painting robot which is one side beforehand. And a coating locus is taught to one painting robot based on these operating points and passing order. Subsequently, carry out mirror conversion of said one painting robot's operating point to the painting robot of another side, and the operating point of the painting robot of this another side is taught to him, and. Inversion conversion of one painting robot's passing order is carried out about the paint path which carries out ganged operation to said one painting robot, and a paint order of the painting robot of this another side is taught. And a coating locus is taught to the painting robot of another side based on these operating points and passing order. Therefore, since the painting robot of another side can be taught based on one painting robot's teaching data, instruction time can be shortened substantially.

[0016]In the invention according to claim 2, three-point attitude instruction of the predetermined operating point which carried out distance alienation is carried out beforehand at a painting robot at least than a painted surface, and the flat surface corresponding to a painted surface is computed from these operating points. Subsequently, specify the operating point of one point as the paint starting point among said operating points of three points, and. Other operating points which differ from said operating point of three points in the field corresponding to a painted surface by specifying the predetermined data of the feed direction of a coating gun, etc. based on these tbe data, Said operating point of three points and the operating point besides the above, and passing order are taught to a painting robot by automatic setup, and a coating locus is taught to a painting robot based on these operating points and passing order. Therefore, since a painting robot can be taught by performing only instruction of the operating point of at least three points, and specification of prescribed data, instruction time can be shortened substantially.

[0017]

[Example]First, the first example of this invention is described. The first example is an example which applied this invention to two painting robots for painting the body of a car.

[0018]Drawing 1 is a lineblock diagram of two painting robots' example taught by this invention method. The same numerals are attached about the same component part as drawing 12 as stated above.

The inside 13 and 14 of drawing 1 is a painting robot which can operate both independently, and on both sides of the body 1 of a car, these painting robots 13 and 14 counter mutually, and are stationed, and they are electrically connected to the controller 6.

[0019]Said painting robots 13 and 14 have the arm 13A and the arm 14A of 6 **** joint mold structure, respectively.

The wrist flange parts 13C and 14C are formed at the tip of these arms 13A and the arm 14A, respectively. For example, it accomplishes a coating gun in these wrist flange parts 13C and 14C, respectively, a rotation atomization type or the exhaust air atomization type spray painting machines 13D and 14D are grasped by these wrist flange parts 13C and 14C, respectively, and they are equipped with them. And these spray painting machines 13D and 14D are controlled by said controller 6 so that operation of the arm 13A and the arm 14A is interlocked with, respectively and conditions, such as spray pattern width, discharge quantity, and regurgitation ON-OFF, are changed.

[0020]Said controller 6 has the function which controls independently said painting robot's 13 arm 13A, and said painting robot's 14 arm 14A, respectively, i.e., the function to build connection relations every six axes, to teach each of the arm 13A and the arm 14A, and to operate it.

For example, it comprises a microcomputer.

And a central processing unit (CPU) which does not illustrate this microcomputer 6, The read only memory (ROM) which stored the processing program, the random access memory (RAM) used as workspace, Input interface circuitry, an input/output interface circuit, an A/D converter, etc. have publicly known hardware constitutions connected via the bidirectional bus line, and with said painting robots 13 and 14. The software operation which mentions this invention method later realizes.

[0021]Next, the processing operation which realizes this invention method is explained with drawing 2, drawing 3, and drawing 4. Drawing 2, drawing 3, and drawing 4 are other explanatory views for explaining the explanatory view for explaining the teach action of the flow chart and painting robot which show an instruction routine, and a painting robot's teach action, respectively.

[0022]The position and posture point of the arm 13A which Step 100 of drawing 2 shows to the painting robot 13, and is shown in drawing 3 by pA1-pA6, i.e., the position and posture point which the spray painting machine 13D of the arm 13A should aim at, is taught.

[0023]Next, the passing order of the position and the posture points pA1-pA6 of said arm 13A is decided at Step 102, and it teaches the painting robot 13, and as shown in drawing 3, two or more coating loci (path) 21A, 21B, and 21C are created. The operating condition for every path is taught to these paths 21A, 21B, and 21C, respectively in this case.

[0024]And the flag F is set on the path 21A, for example, the path, and the path 21B of the arm 13A of the part which carries out ganged operation to the painting robot's 14 arm 14A, and is painted at Step 104, and it can be made to carry out by software automatic distinction.

[0025]Manual operation performs processing operation (instruction) to said step 100 - Step 104 to the painting robot 13.

[0026]Furthermore, According to [as shown in drawing 3] a paint order for the paths 21A, 21B, and 21C created at said step 102, establish and connect the bonds 22A and 22B of a path at Step 106, and teach the painting robot 13 coating-locus pA1 ->pA2 ->pA3 ->pA4 ->pA5 ->pA6, and. The teaching program to the painting robot's 13 arm 13A is created by automatic processing.

[0027]After the instruction to the painting robot 13 is completed by the processing operation of the above-mentioned step 100 - Step 106, instruction to the painting robot 14 is performed by the automatic processing by the software processing of Step 108 - Step 112 described below.

[0028]First, at Step 108 of drawing 2, as shown in drawing 4, mirror conversion of the position and the posture point of the painting robot's 13 arm 13A is carried out about the vertical flat surface S1 to a ground level including center line CL of the cross direction of a body, the position and the posture points pB1-pB6 of the arm B are created, and it teaches the painting robot 14.

[0029]Next, although the passing order of said position and posture points pB1-pB6 is decided at Step 110

and Step 112 and a coating locus (path) is taught to the painting robot 14, Create the paths 23A and 23B of the arm B which carries out inversion conversion of the paint order about the paths 21A and 21B which stand with the path of the arm 13A by 110 first as for the interlocking flag F, and is shown in drawing 4, and. The path 23C of the arm B shown in the figure without carrying out inversion conversion of the paint order about the path 21C which does not stand with the path of the arm 13A as for the interlocking flag F is created, and it teaches the painting robot 14.

[0030]At and the step 112. As shown in drawing 4, the paths 23A, 23B, and 23C created at Step 110. Establish and connect the bonds 24A and 24B of a path in the same order as the paint pass sequence of the arm 13A, and coating-locus pB2 ->pB1 ->pB4 ->pB3 ->pB5 ->pB6 are taught to the painting robot 14, and the teaching program to the painting robot's 14 arm 14A is created by automatic processing.

[0031]According to the 1st above example, as shown in drawing 5, beforehand to on the other hand, the painting robot 13. Teach a coating locus as shown in drawing 5 as the solid line A, and, subsequently based on the teaching data to the painting robot 13, Since the coating locus as automatic processing shown to the painting robot 14 and shown to drawing 5 that these two painting robots do not interfere as the solid line B is taught, instruction time can be shortened substantially.

[0032]A painted surface can be finished for high quality with the painting robots 13 and 14 which taught with the teaching method shown in this example, and independent operation of the front pillar 11 grade can be carried out, respectively, and the two painting robots 13 and 14 can be efficiently painted, for example for it.

[0033]The arm 13A and the arm 14A interlock, and the hood 2, the roof 3, and the luggage 4 which are shown in drawing 5 by carrying out a simultaneous start paint the painting robots 13 and 14 which taught with the teaching method shown in this example, Since the front pillar 11 and the rear pillar 12 become likely to paint independently, the upper surface of the body 1 can be painted efficiently, and it is quality and coating finishing can be carried out. In this case, since it is controlled by the common controller 6, a simultaneous start can be realized easily, and since the flattery characteristic to a dynamic trait is also good, the painting robots 13 and 14 can perform synchronous operation certainly.

[0034]By using the two painting robots 13 and 14 in which the independent operation taught with the teaching method shown in this example is possible and which have been countered and stationed, Since an aim can be independently attached and painted also about the lane garter 25 grade located in both the lateral ends of the roof 3, without being restricted to the front pillar 11 grade of the body 1 upper surface above-mentioned as a painted surface as shown, for example in drawing 6, the amendment paint which was necessity conventionally can be made unnecessary.

[0035]Since there are the two painting robots 13 and 14 independently, respectively, the spray painting machines 13D and 14D, As shown in drawing 7, the position and posture of field direct and the equal distance can be easily taken to boom hoisting of the cross direction (longitudinal direction in a figure) of the body 1, and as shown in drawing 8, the position and posture of field direct and the equal distance can be easily taken to the front pillar 11, the rear pillar 12, etc.

[0036]Next, the second example of this invention is described. The second example is an example which applied this invention to one painting robot for painting the body of a car.
[0037]Drawing 9 is a lineblock diagram of one painting robot's example taught by this invention method. The same numerals are attached about the same component part as drawing 13 as stated above. Eight in drawing 9 is a painting robot, and this painting robot 8 is stationed at one side (drawing 9 left-hand side) of the body 1 of a car, and he is electrically connected to the controller 6.
[0038]Said painting robot 8 has the arm 8A of 6 **** joint mold structure, and the wrist flange part 8C is formed at the tip of this arm 8A. This wrist flange part 8C is grasped and equipped with the coating gun 9 which comprises a rotation atomization type spray painting machine etc. at the wrist flange part 8C.
[0039]And this coating gun 9 is controlled by the controller 6 so that operation of the arm 8A is interlocked with like the first above-mentioned example and conditions, such as discharge quantity, are changed. The controller 6 has the same publicly known hardware constitutions as the first above-mentioned example, and realizes them by software operation which mentions this invention method later with said painting robot 8.
[0040]Next, the processing operation which realizes this invention method is explained with drawing 10 and drawing 11. Drawing 10 and drawing 11 are the explanatory views of operation for explaining the teach action of the flow chart and painting robot which show an instruction routine, respectively.
[0041]P1 and P2 which are shown at Step 200 of drawing 10, three points, for example, drawing 11, which estranged only the constant distance d from the painted surface first, and P9 are taught to the painting robot 8. This instruction is performed by locating the tip of the coating gun 9 in the point that only the constant distance d estranged from the painted surface as mentioned already in the "PRIOR ART" column.

[0042]Next, a flat surface is computed at Step 202 from the data of the three-point attitude part of said P1, P2, and P3. At a ceremony of the xyz flat surface specifically shown by the following (1) formula, P1, P2, and each coordinates of P3 (x_1, y_1, z_1), A flat surface is computed by substituting (x_2, y_2, z_2), and (x_3, y_3, z_3), and solving simultaneous equations.

[0043]

ax+by+cz=1 The paint starting point is determined and inputted from the inside of the three above-mentioned points at (1) and Step 204. Let P1 be the paint starting point in this example.
[0044]Subsequently, the feed direction of the coating gun 9 is inputted at Step 206, and the feed distance of the coating gun 9 is inputted at Step 208. The arrow C aims to show the feed direction in this example to drawing 11, and feed distance is the distance shown in the figure by d, i.e., the distance between P1 and P2. When specifying sending the coating gun 9 from the paint starting point P1 to the point P2 like this example, it is not necessary to necessarily carry out the numerical input of the feed distance d.
[0045]The amount of paint path pitches (the distance shown in drawing 11 by l in this example, i.e., distance between P1 and P3) is inputted at Step 210, and paint passing time is inputted at Step 212. It is referred to as paint passing time =4 in this example.

[0046]And as the painting robot's 8 the operating point and operation order show drawing 11 at Step 212 in the plane region computed at the above-mentioned step 202 from the conditions inputted at each above-mentioned step, it is created automatically, Coating-locus P1->P2->P3-> as shown to the painting robot 8 as the solid line A at the figure -- ->P8 ->P9 ->P10 is taught and teaching work is completed.

[0047]According to the second above example, make the painting robot 8 correspond to a painted surface, and teach the operating point of three points beforehand, and. Input the feed direction of the paint starting point and a coating gun, etc., and set up automatically and teach the painting robot 8 other different operating points and passing order from said operating point of three points based on these data, and. Since the coating locus is taught to the painting robot 8 based on these operating points and passing order, instruction time can be shortened substantially. If the instruction man day per [by the conventional method] point is made into 5 minutes, when ten points (P1-P10) are taught by the conventional method like this example, the instruction time for 5-minute [/point] x ten point = 50 minutes is specifically needed, but. Since it will end in instruction time for 5-minute [/point] x three-point +5-minute (processing time of Steps 202-214 shown in drawing 10) = 20 minutes if it teaches by this invention method, instruction time can be shortened substantially. and in the conventional teaching method, the number of teaching points increases 1 point, although it is alike and instruction time is added every [5], Since the processing time of Steps 202-214 shown in drawing 10 in this invention method is approximately regulated irrespective of some of numbers of teaching points, the shortening effect of the instruction time by this invention method becomes large further as the number of teaching points increases.

[0048]Since what is necessary is just to use the data of said flat surface, copying when changing only cancer feed distance in subsequent instruction once it teaches the painting robot 8 a flat surface at Step 202 of drawing 10, In such change etc., it can teach easily in a short time.

[0049]The point taught in the above-mentioned example according to a painted surface at Step 200 of drawing 10 is not what is restricted to three points, A coating locus can be taught to a painting robot even if a painted surface is a curved surface by computing the curved surface of a rural curved surface etc. from the data for a four point at Step 202, when it may be more than a four point, for example, a four point is taught.

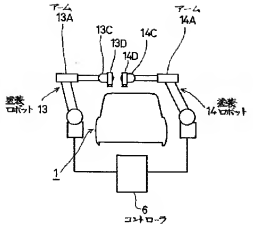
[0050]

[Effect of the Invention]According to the invention according to claim 1, since the painting robot which is one side beforehand is taught and it is teaching not interfering with the painting robot of another side with one painting robot based on this teaching data, instruction time can be shortened substantially.

[0051]According to the invention according to claim 2, the operating point of at least three points is beforehand taught to a painting robot, Since other operating points and passing order are set up automatically and taught based on tbe data, such as a feed direction of these operating points and a coating gun, instruction time can be substantially shortened like the invention according to claim 1.

[Translation done.]

【図1】



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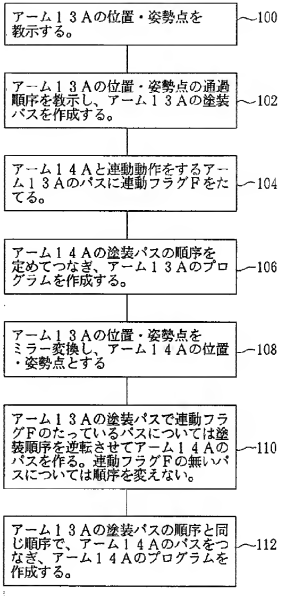

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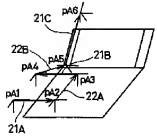

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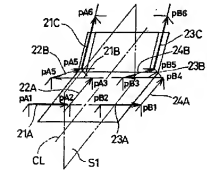

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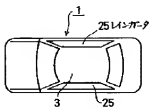

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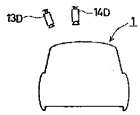

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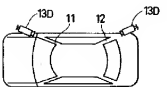

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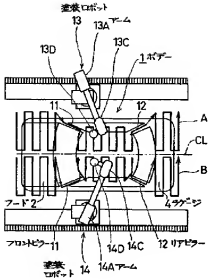

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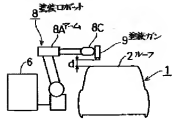

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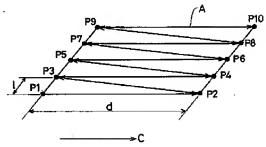

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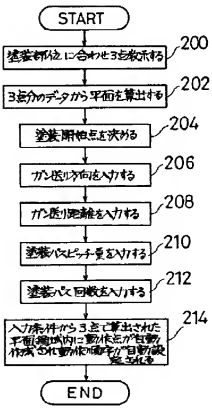

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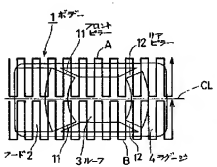
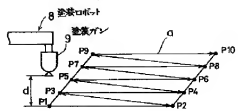


【図１４】



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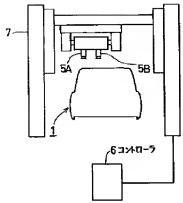
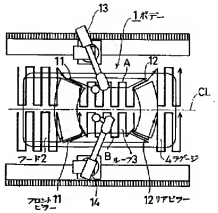


【図１５】



フロントページの続き

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